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Development of Experiment-Based Physics Worksheets in Science in Developing Students' Science Process Skills

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Abstract: Experiment-based research on the development of student worksheets (SW) in Science Physics has been carried out to Grow Students' Science Process Skills. This study aims to produce a valid, practical, and effective experimental-based student worksheet product. The research method used is the method of research and development (Research and Development). Experiment-based student worksheet development uses the ADDIE model which consists of the Analysis, Design, Development, Implementation, and Evaluation stages. The students involved in this study were 32 class VIII students at SMPN 51 Makassar and 7 Physics Educators who joined the MGMP IPA in the city of Makassar. The research instruments used were expert validity questionnaires, educator response questionnaires, and science process skills tests. After analyzing the validation data according to Aiken's, an expert agreement index was obtained for scientific literacy-based worksheets of 0.79, an expert response questionnaire index of 0.80, and an expert agreement index of science process skills tests of 0.83 so that all three were declared valid. Practitioners' assessment obtained an overall percentage of 90.80% which is in the very good category. Meanwhile, in terms of science process skills, students who achieve mastery learning are 75% and those who do not achieve completeness are 25%. So that it can be stated that experimental-based worksheets in science learning physics are effective for growing students' science process skills.

Keywords: Student Worksheets; Process Science; Science Process Skills

Introduction

Education can be seen as the essence of life for both personal and societal development to face the hopes and challenges of a better future. The main goal of education is to fully develop individual talents, realize creative potential, and achieve personal goals and personal responsibility for social life in society (Taufik et al., 2010). Natural Sciences (known as IPA) is the study of the entire universe and its contents. However, science has limited knowledge, namely things that can only be understood by the senses (sight, hearing, taste, touch, and touch). It can also be said that Science/Physics is the knowledge that is acquired through learning and proof (Aji et al., 2017).

The learning model in the 2013 curriculum requires students to be actively involved in the learning process in class. Scientific activities carried out in the laboratory shows that students can acquire physics concepts and have skills. In addition, teaching materials can also help provide clear guidelines regarding the competencies that students must achieve (Khuzaimah et al., 2022). The 2013 curriculum is considered successful in encouraging students to be more authentic, skilled, and active in delivering material, as well as being more flexible in developing the information obtained (Nuryani et al, 2022).

To fulfill these demands, many efforts have been made, including using teaching materials that contain creative thinking skills needed as a facility for exploring the potential knowledge and skills of students. The development of making Student Worksheets is one of these efforts. It is hoped that students can develop their knowledge and skills

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through learning using Student Worksheets (Aldiyah, 2021). Student worksheet emphasizes more on the process of finding concepts and in which there are variations of stimulus through various media and student activities that make learning more meaningful, effective, and fun. This statement is supported by (Islami et al., 2019) who ststatehat the teaching and learning process will run actively, effectively, creatively, interestingly, and fun if it is supported by the availability of learning resources, and one of the learning resources that can be used is student worksheets to optimize engagement. students in the learning process.

Based on observations made at SMPN 51 Makassar, where this school is a new school that was founded in 2019, so it does not yet have adequate learning facilities, especially science physics practicum tools. Based on the results of interviews with science teachers, it was obtained information that worksheets were not yet available to help optimize learning in class, worksheets for science practicums currently used were only in textbooks and modules that only developed cognitive aspects, so special worksheets needed to be developed for experiments. The textbooks and modules used have not been able to guide students in experimental activities. Work steps were given in writing on the blackboard and orally during the experiment, and delivered orally when there were students who asked for clarity of work steps. The source comes from the knowledge possessed by educators and some are obtained from handbooks that are often used by educators and students during teaching and learning activities. The experimental guidelines contained in the book do not yet have aspects of science process skills that can foster the ability to formulate problems, hypotheses, measure, and communicate. Students need appropriate student worksheets to be able to follow the 2013 curriculum learning model that has been implemented so that the learning process can run well.

Student worksheets used in the learning process must be able to stimulate students to be able to experiment in the field. Educators also often find it difficult to assess students' abilities in predicting, measuring, and communicating material. The student worksheets must contain a process for assessing students' work results and measuring students' abilities in predicting, measuring, and communicating on a material. Students must be actively involved in learning such as finding knowledge, proving this knowledge through a practicum or experiment, and concluding it so that in the end they can create a tool or technology that can later solve the problems faced by society (Kristyowati, 2019).

Student worksheets that are commonly used by teachers come from various publishers and only contain material, questions, and student activities. This student worksheet has not been integrated with the local culture of wisdom or ethnoscience in the community so it does not teach students scientific things that are contextually experienced in their environment. Student worksheets like this cannot accommodate students' critical thinking and science skills (Widyawati et al., 2020). Therefore, learning using these student worksheets is expected to form an effective two-way interaction between teacher and students so that learning objectives can be achieved (Gusti et al., 2021).

Ongowo & Indoshi (2013) argue that science process skills help students to develop a sense of responsibility in learning and increase the importance of research methods in the learning process. Science process skills aim to enable students to be more active in understanding and mastering the sequences they do such as observing/observing, grouping/classifying, interpreting/interpreting, predicting/predicting, hypothesizing, planning experiments/research, and communicating (Prasasti, 2017). This skill needs to be understood by teachers because it is important in learning science (Rauf, et al., 2013).

Previous research conducted by Eva et al. (2019) concluded that learning tools in the form of experiment-based worksheets are needed to increase student activity in the learning process, and can assist teachers in directing their students to find concepts through their activities. Besides that, it can be used to develop students' science process skills in participating in learning. Thus, it is suspected that the experimental-based worksheets that have been developed and declared valid or suitable for use according to experts both from the feasibility of content, presentation, language, and graphics, are practical according to practitioners' assessments, and are effective for teacher use in learning according to the achievement of completeness of student learning outcomes can foster students' science process skills.

Method

This research is a Research and Development (R&D) type of research or development research using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The stages of ADDIE's research and development can be seen in Figure 1.

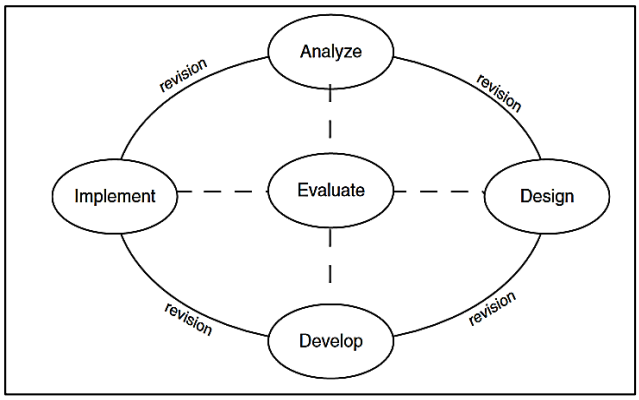

Figure 1. ADDIE Development Model (Branch, 2009)

This study used data collection techniques in the form of validation, questionnaires, and tests of science process skills. This study used research subjects of class VIII students consisting of 32 students. Held in the Even Semester of the 2021/2022 Academic Year and took place at SMP Negeri 51 Makassar. The analysis used to determine the level of relevance by three experts used the content validity coefficient (Aiken's V). The Aiken's V formula is used to calculate the content validity coefficient which is based on the results of each expert's assessment of an item using Formula 1 (Azwar, 2012).

$$V = \frac{\sum s}{n-(c-1)} \quad (1)$$

Explanation:
V : Index of expert agreement on item validation
s : The difference in the score determined by each expert with the lowest score in the category used
s : r-I_o
r : Rater set score
I_o : Lowest rating score
N : Lots of experts
c : The highest validity rating score

The terms of the Aiken test, after calculating if V ≥ 0.4 then the expert agreement index is said to be valid. Based on the analysis of expert validation data that has been carried out, the value of V obtained is 0.79 for expert validation of experiment-based worksheets, 0.80 for expert validation of practitioner assessment questionnaires, and 0.83 for expert validation of students' science process skills tests. So it can be concluded that the expert agreement index states that the research instrument is valid and can be tried out. Data on practitioners' assessment of experimental-based student worksheets as stated in the questionnaire sheet were analyzed using Formula 2.

$$PRS = \frac{\sum A}{\sum B} \times 100\% \quad (2)$$

Explanation:
PRS = The percentage of the number of practitioners who respond to the categories stated in the instrument
∑A = The total score obtained for each category is stated in the questionnaire
∑B = The maximum score of each category that responds to the questionnaire

Calculating the percentage of practitioners' ratings for each statement with the interpretation criteria of practitioners' assessment scores is presented in Table 1. The effectiveness of experiment-based worksheets can be seen through the ability of students' science process skills. The completeness standard follows Permendikbud Number 23 of 2016, namely an assessment with a range of 1-100 where to determine the value of individual completeness descriptively is calculated using Formula 3 (Prastowo, 2015).

Table 1. Criteria for Interpretation of Practitioner Assessment Scores

Percentage (%)	Criteria
0-25	Very less
26-50	Not enough
51-75	Good
76-100	Very good

(Source: Riduwan, 2011)

$$KB = \frac{T}{T_1} \times 100\% \quad (3)$$

Explanation:
KB : Learning completeness (individual)
T : The number of scores obtained by students
T_1 : The total score

The calculation results are then interpreted using an assessment classification as shown in Table 2.

Table 2. Classification of Assessment of Effectiveness

Percentage (%)	Criteria
86 – 100	Very Good
72 – 85	Good
58 – 71	Enough
43 – 57	Not Enough
≤ 43	Very Less

Source : Djaali & Muljono (2016)

The effectiveness of experiment-based worksheets can be seen from the scores of students' science process skills after being tested on experiment-based worksheets. A class is said to have completed its learning (classical completeness) if ≥ 75% of students have completed their studies out of the total number of

students. Classical mastery can be calculated by Formula 4 (Trianto, 2013).

$$N_{\text{classical}} = \frac{P_T}{P_S} x\ 100\% \quad (4)$$

Explanation:
$N_{\text{classical}}$ = The percentage value of students' classical learning completeness
P_T = Number of students who complete the study
P_S = The total number of students.

Results and Discussion

The results of the experimental-based student worksheets validation analysis which were validated by 3 experts were obtained in Table 3.

Table 3. Problem-Based Physics E-module Content Validity Analysis Test

Aspect	V	Category
Content Eligibility	0.79	Valid
Eligibility of Presentation	0.78	Valid
Language Eligibility	0.78	Valid
Graphic Eligibility	0.83	Valid

In the content feasibility aspect, a validity index (V) is obtained with an average score of 0.79 and is in the valid category, then for the presentation feasibility aspect, a validity index (V) is obtained with an average score of 0.78 and is in the valid category, for the language feasibility aspect, a validity index is obtained (V) with an average score of 0.78 and is in the valid category, and for the graphical feasibility aspect, the validity index (V) is obtained with an average score of 0.83 and is in the valid category. The results of the analysis of practitioner questionnaire sheets on the experimental-based student worksheets developed are as table 4.

Table 4. Test Results of Analysis of the Validity of the Practitioner Response Questionnaire Contents with the Aiken's V Index

Aspect	V	Category
Content Eligibility	0.80	Valid
Eligibility of Presentation	0.80	Valid
Language Eligibility	0.78	Valid
Graphic Eligibility	0.84	Valid

The magnitude of the practitioner's assessment is calculated by looking at the percentage of the score given by the practitioner in each category stated in the questionnaire. Practitioners who filled out the experimental-based student worksheets development assessment questionnaire were 7 science-physics teachers at junior high schools throughout Makassar. The results of the analysis of several practitioners' responses are then tabulated in Table 5.

Table 5. Scores of Practitioners' Assessment of the Quality of Experiment-Based student worksheets Development

Aspect	Practitioner Score							Percentage (%)
	P1	P2	P3	P4	P5	P6	P7	
Content Eligibility	18	19	18	20	17	17	17	90.00
Eligibility of Presentation	21	23	22	24	20	22	24	92.86
Language Eligibility	14	15	15	16	11	14	15	89.29
Graphic Eligibility	24	23	22	22	21	23	18	91.07

The results of the analysis of students' science process skills tests after being given experimental-based worksheets are tabulated in Table 6.

Table 6. Value of Science Process Skills for Class VIII A Students of SMPN 51 Makassar

Percentage (%)	Classification	Number of Students
86 – 100	Very good	1
72 – 85	Good	12
58 – 71	Enough	19
43 – 57	Not Enough	0
≤ 43	Very Less	0

The percentage of students' science process skills based on the achievement of minimum and classical completeness scores after being given an experiment-based worksheet for class XI SMPN 51 Makassar can be seen in Table 7.

Tabel 7. Ketuntasan Hasil Belajar Individu dan Klasikal Peserta Didik

Minimum Completeness Criteria	Classification	Number of Students	Percentage (%)
≥65	Complete	24	75
< 65	Not Completed	8	25

Individual and classical completeness after participating in learning using experimental-based worksheets on vibration and wave material obtained from 32 students who took the test obtained as many as 24 students passed and 8 students did not complete. Classically, student completeness is 75%, said to be complete because it achieves the predetermined

classical completeness criteria, namely ≥ 75%. This was reinforced by Arimurti & Purnomo's research (2018) that Problem-Based Learning worksheets were developed to improve students' science process skills to achieve 87% student completeness (Safitri et al., 2022). Overall, a conclusion can be drawn that there are effective experimental-based worksheets used in developing the science process skills of Class VIIIa students of SMPN 51 Makassar.

Practitioner response questionnaires were assessed using a Likert scale with rating categories namely 1 (very irrelevant/very inappropriate), 2 (irrelevant/inappropriate), 3 (relevant/appropriate), 4 (very relevant/very appropriate). The average practitioner response questionnaire analysis results obtained a percentage of 90.80%. The effectiveness of student worksheets based on science process skills can be seen from the results of students' science process skills tests. A total of 24 students met the minimum passing standards set, while 8 students did not. In other words, 75% of class VIII students have achieved the specified Minimum Completeness Criteria.

Based on the results of the students' science process skill tests and the theory of effectiveness, it can be stated that the students' classical learning completeness has met the minimum standard of mastery. As for one of the factors that influence there are still students who have not met the minimum completeness due to the limited experimental tools and materials used so that students do not have more opportunities to practice their science process skills during the experimental process.

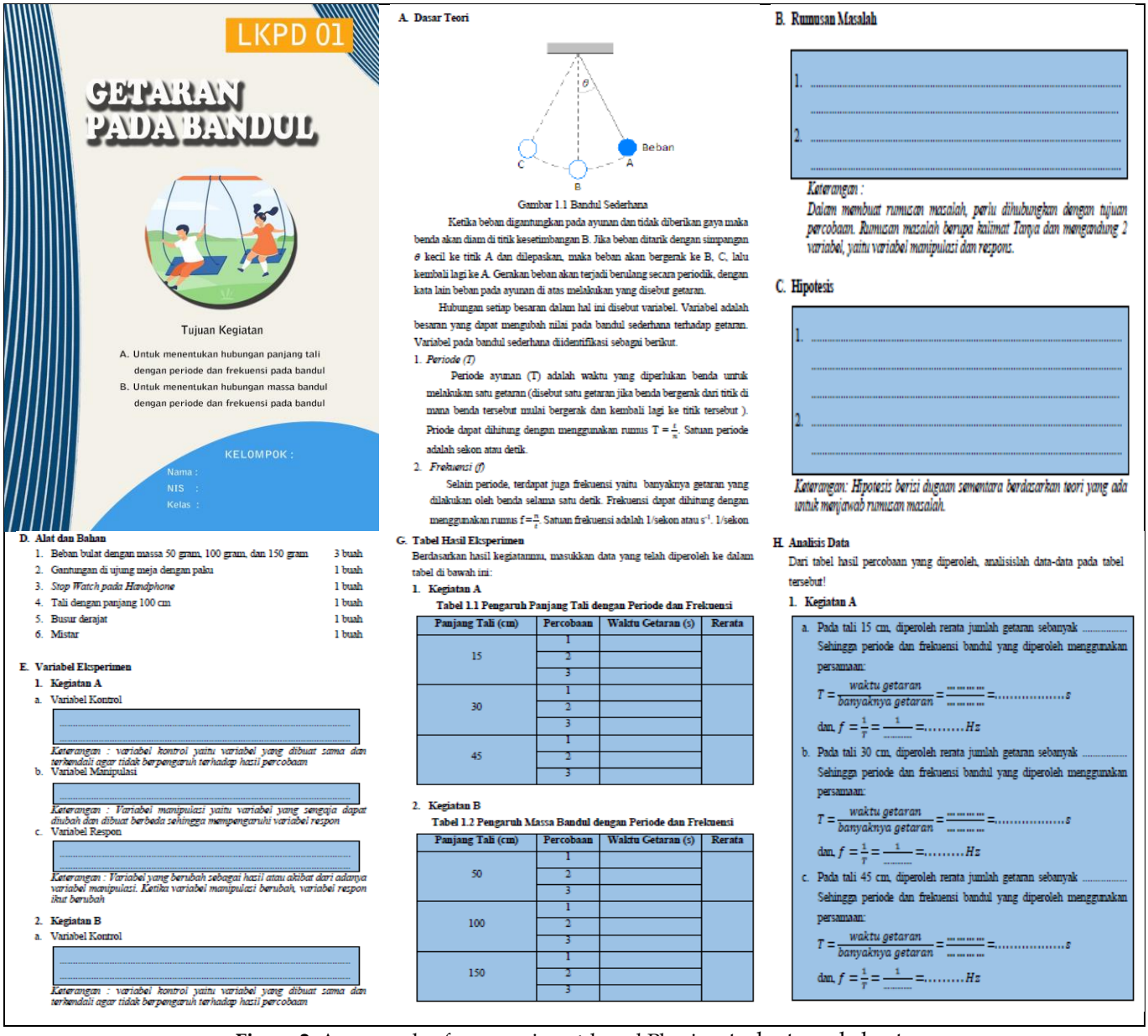

Figure 2. An example of an experiment-based Physics student worksheets

Conclusion

Based on the research that has been done, it can be concluded that the experimental-based student worksheets in science learning class VIII meet the criteria of being valid/fit for testing based on the results of expert agreement index analysis with an Aiken's V validity coefficient of 0.79. In addition, practitioners' assessment of student worksheets based on experiments in science learning class VIII SMPN 51 Makassar which has been developed gives a positive assessment with a percentage of 90.80% and is in the very good category. Furthermore, the effectiveness of using experiment-based worksheets to cultivate the science process skills of class VIII students of SMPN 51 Makassar meets the classical completeness criteria with a percentage of 75% of students fulfilling the Minimum Completeness Criteria.

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